Q
181.5
A3217
1994
gr.10
CURRGDHT

EX LIBRIS
UNIVERSITATIS
ALBERTÆNSIS

Science 10
Course of Studies

Curriculum Standards Branch
Interim
May 31, 1994

Alberta
EDUCATION

UNIVERSITY LIBRARY
UNIVERSITY OF ALBERTA

SCIENCE

VISION STATEMENT: SENIOR HIGH SCIENCE PROGRAMS

The senior high science programs will help all students attain the scientific awareness needed to function as effective members of society. Students will be able to pursue further studies and careers in science, and come to a better understanding of themselves and the world around them. The same framework was used for the development of all the senior high science programs, including Science 10, Biology 20–30, Chemistry 20–30, Physics 20–30 and Science 20–30. The expected student knowledge, skills and attitudes are approached from a common philosophical position in each science course.

In the senior high science programs, students focus on learning the big interconnecting ideas and principles. These ideas, or major themes, originate from science knowledge that transcends and unifies the natural science disciplines. These themes include change, diversity, energy, equilibrium, matter and systems; the process by which scientific knowledge is developed, including the role of experimental evidence; and the connections among science, technology and society. In addition to forming a framework for the curriculum, these ideas provide continuity with the junior high program and build on students' previous learning.

The senior high science programs place an increased emphasis on developing methods of inquiry that characterize the study of science. For example, students will further their ability to ask questions, investigate and experiment; gather, analyze and assess scientific information; and test scientific principles and their applications. They will develop their problem-solving ability and use technology. By providing students with opportunities to develop and apply these skills, they will better understand the knowledge they have acquired.

Students will be expected to show an appreciation for the roles of science and technology in understanding nature. They will possess enthusiasm and positive attitudes toward science and maintain a lifelong interest in science.

The learning context is an integral part of the senior high science programs. It will foster the expected attitudes in students, further the development of students' skills and increase students' understanding of science knowledge, science process, and the connections among science, technology and society. The context for learning will be relevant so students will experience science as interesting and dynamic. Learning opportunities will be made meaningful by providing concrete experiences that students can relate to their world.

The senior high science programs place students at the centre. Students are active learners and will assume increased responsibility for their learning. They will appreciate the value of teamwork and make a positive contribution when working with others to solve problems and complete tasks.

SCIENCE 10

A. COURSE RATIONALE AND PHILOSOPHY

Science by its very nature is interesting, exciting and dynamic. Through the study of science, learners are given an opportunity to explore and understand the natural world and to become aware of the profound influence of science in their lives. Learning is facilitated by relating the study of science to what the learners already know, deem personally useful and consider relevant. Learning proceeds best when it originates from a base of concrete experiences presenting an authentic view of science. In Science 10, students learn science in relevant contexts and engage in meaningful activities. This facilitates the transfer of knowledge to new contexts. Students are encouraged to participate in lifelong learning about science and to appreciate it as an endeavour with practical impact on their own lives and on society as a whole.

Science is an experimental discipline requiring creativity and imagination. Methods of inquiry characterize its study. In Science 10, students further develop their ability to ask questions, investigate and experiment; to gather, analyze and assess scientific information; and to test scientific laws and principles and their applications. In the process, students exercise their creativity and develop their critical thinking skills. Through experimentation, problem-solving activities and independent study, students develop an understanding of the processes by which scientific knowledge evolves.

The Science 10 course places students at the centre. Students are active learners and will assume increased responsibility for their learning as they work through the course. A thorough study of science is required to give students an understanding that encourages them to make appropriate applications of scientific concepts to their daily lives and prepares them for future studies in science. Students are expected to participate actively in their own learning. An emphasis on the key concepts and principles of science provides students with a more unified view of the sciences and a greater awareness of the connections among them.

These science learnings will take varying amounts of time to acquire, depending on the individual learning styles and abilities of students. While the course is designed for approximately 125 hours, instructional time can be modified to meet the individual needs of students. Some students will require more than 125 hours, while others will require less.

GOALS

The major goals of the Science 10 course are:

- to develop in students an understanding of the interconnecting ideas and principles that transcend and unify the natural science disciplines
- to provide students with an enhanced understanding of the scientific world view, inquiry and enterprise

- to help students attain the level of scientific awareness essential for all citizens in a scientifically literate society

- to help students make informed decisions about further studies and careers in science

- to provide students with opportunities for acquiring knowledge, skills and attitudes that contribute to personal development.

Science 10 is an integrated academic course that helps students better understand and apply fundamental concepts and skills common to biology, chemistry, physics and the Earth sciences. Science 10 is a prerequisite for the 20-level science courses. The focus is on helping students understand the scientific principles behind the natural events they experience and the technology they use in their daily lives. The course encourages enthusiasm for the scientific enterprise and develops positive attitudes about science as an interesting human activity with personal meaning. It develops in students the knowledge, skills and attitudes to help them become capable of, and committed to, setting goals, making informed choices and acting in ways that will improve their own lives and life in their communities.

B. GENERAL LEARNER EXPECTATIONS

The general learner expectations outline the many facets of scientific awareness and serve as the foundation for the specific learner expectations covered in section C. The general learner expectations are developed in two categories: *program* expectations and *course* expectations.

PROGRAM GENERAL LEARNER EXPECTATIONS

Science 10 serves as the prerequisite for Biology 20–30, Chemistry 20–30, Physics 20–30 and Science 20–30. The *program* general learner expectations listed here apply to Science 10 in combination with each of the other four programs.

The *program* general learner expectations are broad statements of science attitudes, knowledge, skills and science, technology and society (STS) connections that students are expected to achieve in all of the senior high school science programs. These *program* general learner expectations are further refined through the *course* general learner expectations and then developed in specific detail through the study of individual units in Science 10 and each of the sciences at the 20 and 30 level. All expectations follow a progression from Science 10 through to each of the 30-level sciences, and though listed separately, are meant to be developed in conjunction with one another, within a context.

ATTITUDES

Students will be encouraged to develop:

- enthusiasm for, and a continuing interest in, science
- affective attributes of scientists at work; such as, respect for evidence, tolerance of uncertainty, intellectual honesty, creativity, perseverance, cooperation, curiosity and a desire to understand
- positive attitudes toward scientific skills involving mathematics, problem-solving and process skills
- open-mindedness and respect for the points of view of others
- sensitivity to the living and nonliving environment
- appreciation of the roles of science and technology in our understanding of the natural world.

KNOWLEDGE

Science Themes

Students will be expected to demonstrate an understanding of themes that transcend the discipline boundaries, and show the unity among the natural sciences, including:

- Change: how all natural entities are modified over time, how the direction of change might be predicted and, in some instances, how change can be controlled
- Diversity: the array of living and nonliving forms of matter and the procedures used to understand, classify and distinguish those forms on the basis of recurring patterns
- Energy: the capacity for doing work that drives much of what takes place in the Universe through its variety of interconvertible forms
- Equilibrium: the state in which opposing forces or processes balance in a static or dynamic way
- Matter: the constituent parts, and the variety of states of the material in the physical world

- Systems: the interrelated groups of things or events that can be defined by their boundaries and, in some instances, by their inputs and outputs.

SKILLS

Students will be expected to develop an ability to use thinking processes associated with the practice of science for understanding and exploring natural phenomena, problem solving and decision making. Students will also be expected to use teamwork, respect the points of view of others, make reasonable compromises, contribute ideas and effort, and lead when appropriate to achieve the best results. These processes involve many skills that are to be developed within the context of the program content.

The skills framework presented here assumes that thinking processes often begin with an unresolved problem or issue, or an unanswered question. The problem, issue or question is usually defined and hypotheses formulated before information gathering can begin. At certain points in the process, the information needs to be organized and analyzed. Additional ideas may be generated—for example, by prediction or inference—and these new ideas, when incorporated into previous learning, can create a new knowledge structure. Eventually, an outcome, such as a solution, an answer or a decision is reached. Finally, criteria are established to judge ideas and information in order to assess both the problem-solving process and its outcomes.

The following skills are not intended to be developed sequentially or separately. Effective thinking appears to be nonlinear and recursive. Students should be able to access skills and strategies flexibly; select and use a skill, process or technology that is appropriate to the task; and monitor, modify or replace it with a more effective strategy.

- Initiating and Planning
  - identify and clearly state the problem or issue to be investigated
  - differentiate between relevant and irrelevant data or information
  - assemble and record background information
  - identify all variables and controls
  - identify materials and apparatus required
  - formulate questions, hypotheses and/or predictions to guide research
  - design and/or describe a plan for research, or to solve a problem
  - prepare required observation charts or diagrams, and carry out preliminary calculations
- Collecting and Recording
  - carry out the procedure and modify, if necessary
  - organize and correctly use apparatus and materials to collect reliable data
  - observe, gather and record data or information accurately according to safety regulations; e.g., Workplace Hazardous Materials Information System (WHMIS), and environmental considerations
- Organizing and Communicating
  - organize and present data (themes, groups, tables, graphs, flow charts and Venn diagrams) in a concise and effective form
  - communicate data more effectively, using mathematical and statistical calculations, where necessary
  - express measured and calculated quantities to the appropriate number of significant digits, using SI notation for all quantities
  - communicate findings of investigations in a clearly written report
- Analyzing
  - analyze data or information for trends, patterns, relationships, reliability and accuracy
  - identify and discuss sources of error and their affect on results
  - identify assumptions, attributes, biases, claims or reasons
  - identify main ideas

- Connecting, Synthesizing and Integrating
  - predict from data or information, and determine whether or not these data verify or falsify the hypothesis and/or prediction
  - formulate further testable hypotheses supported by the knowledge and understanding generated
  - identify further problems or issues to be investigated
  - identify alternative courses of action, experimental designs, and solutions to problems for consideration
  - propose and explain interpretations or conclusions
  - develop theoretical explanations
  - relate the data or information to laws, principles, models or theories identified in background information
  - propose solutions to a problem being investigated
  - summarize and communicate findings
  - decide on a course of action
- Evaluating the Process or Outcomes
  - establish criteria to judge data or information
  - consider consequences and biases, assumptions and perspectives
  - identify limitations of the data or information, and interpretations or conclusions, as a result of the experimental/research/project/design process or method used
  - evaluate and suggest alternatives and consider improvements to the experimental technique and design, the decision-making or the problem-solving process
  - evaluate and assess ideas, information and alternatives

CONNECTIONS AMONG SCIENCE, TECHNOLOGY AND SOCIETY

Science, Technology and Society (STS)

Students will be expected to demonstrate an understanding of the processes by which scientific knowledge is developed, and of the interrelationships among science, technology and society, including:

- the central role of evidence in the accumulation of knowledge, and the way in which proposed theories may be supported, modified or refuted
- the inability of science to provide complete answers to all questions
- the functioning of products or processes based on scientific principles
- the ways in which science advances technology and technology advances science
- the use of technology to solve practical problems
- the limitations of scientific knowledge and technology
- the influence of the needs, interests and financial support of society on scientific and technological research
- the ability and responsibility of society, through science and technology, to protect the environment and use natural resources judiciously to ensure quality of life for future generations.

FURTHER READING

For a more detailed discussion on how to integrate thinking and research skills into the science classroom, refer to the Alberta Education publications: *Teaching Thinking: Enhancing Learning*, 1990 and *Focus on Research: A Guide to Developing Students' Research Skills*, 1990.

For further reading on integrating science, technology and society into the classroom, refer to the Alberta Education publication: *STS Science Education: Unifying the Goals of Science Education*, 1990.

COURSE GENERAL LEARNER EXPECTATIONS

The *course* general learner expectations are specific to Science 10 and provide a bridge between the *program* general learner expectations and the specific learner expectations for each unit of study.

The attitudes expectations refer to those predispositions that are to be fostered in students. These expectations encompass attitudes toward science, the role of science and technology, and the contributions of science and technology toward society. The knowledge expectations are the major science concepts in the course. The skills expectations refer to the thinking processes and abilities associated with the practice of science, including understanding and exploring natural phenomena, and problem solving. The connections among science, technology and society expectations focus on the processes by which scientific knowledge is developed and on the interrelationships among science, technology and society.

The last *course* expectation links together the study of science, careers, everyday life and subsequent studies.

Although itemized separately, the attitudes, knowledge, skills and STS connections are meant to be developed together within one or more of the contexts listed.

Attitudes

Students will be encouraged to:

- appreciate the role of empirical evidence and models in science, and accept the uncertainty in explanations and interpretations of observed phenomena
- value the curiosity, openness to new ideas, creativity, perseverance and cooperative hard work required of scientists, and strive to develop these same personal characteristics
- appreciate the role of science and technology in advancing our understanding of the natural world, be open-minded and respectful of other points of view when evaluating scientific information and its applications, and appreciate that the application of science and technology by humankind can have both beneficial and harmful effects and can cause ethical dilemmas
- show a continuing interest in science, appreciate the need for computational competence, problem-solving and process skills when doing science, and value accuracy and honesty when communicating the results of problems and investigations
- appreciate the contributions of the various science disciplines and mathematics to our understanding of the natural world, and appreciate the multidimensional nature of issues arising from the interrelationships among science, technology and society.

Students should be able to:

Knowledge

- describe how energy and matter are transferred in all physical and biochemical changes; and identify energy transfers in the hydrologic cycle, photosynthesis and cellular respiration, the combustion of fuels, and energy conversion devices
- explain that energy and matter exist in many forms and are transferred, moved and conserved in and among physical, chemical and biological systems
- apply the law of energy conservation to energy transfer, calculating efficiency; and identify ways of conserving energy
- use the relationships among force, distance, work, energy and time to describe how energy is measured; and compare the functioning of common energy conversion devices
- apply the principle of conservation of matter to calculations and investigations into chemical changes that produce substances useful to society and/or may have unpredictable effects on the environment

- describe atoms, ions and molecules; and investigate the chemical and physical properties of common elements and compounds; and apply the classification system to identify elements, ionic and molecular compounds, and common household substances

Skills

- perform investigations, tasks and procedures, designed by others, that have a few, simple variables, yield direct evidence, and require empirically-based explanations

- collect, verify and organize data into tables, graphs and diagrams designed by others, and put into written form; and describe findings or relationships, using scientific vocabulary, notation and concepts

- plot data that yield straight-line graphs; and use appropriate SI notation, fundamental and derived units and formulas; and determine slopes of, and areas under, straight-line graphs

- use mathematical language of ratio and proportion, and simple equations, to solve numerical problems; and use chemical equations and nomenclature to communicate scientific ideas, relationships and concepts

Connections Among Science, Technology and Society

- list for a given instance, appropriate and relevant examples that relate direct scientific evidence to a theory; and describe the limitations of science and technology in answering all questions and solving all problems

- list for a given instance, appropriate and relevant examples of technological solutions to practical problems; and describe the functioning of technologies, using scientific principles; and relate the ways in which science and technology advance one another

- identify for a given instance, appropriate and relevant examples that show how science and technology are influenced and supported by society; and describe the responsibility of society through science and technology to protect the environment and use natural resources wisely

- identify subject-related careers and apply the skills and knowledge acquired in Science 10 to everyday life and to related and new concepts in subsequent studies of science.

C. SPECIFIC LEARNER EXPECTATIONS

LEARNING CYCLE

The specific learner expectations consist of the knowledge, skills and attitudes that are to be addressed in Science 10. The use of the learning cycle allows students to progress from:

- an introduction framing the lesson in an STS connection relevant to the lives of the learners, and makes connections between past and present learning experiences, as well as anticipates activities to focus students' thinking on the learning outcomes of the activity, to
- the experiential exploration of new content that provides students with a common base of experiences within which they identify and develop key concepts, processes and skills, through
- a hypothesis-building phase where concepts are developed to describe a particular aspect of their experiential exploration, and opportunities are provided to communicate their conceptual understanding, or demonstrate their skills or behaviours, to
- an elaboration phase that extends understanding of key concepts and allows further opportunities to practise desired skills and problem-solving strategies, to
- an application phase where the hypotheses, vocabulary and patterns previously developed are applied to new situations and related to key concepts and principles of science, to
- a final evaluation of the significance of the new learning in an STS context to assess their understanding and abilities, and provide opportunities for teachers to evaluate student progress toward achieving the curriculum standards.

In science, students examine phenomena in a variety of topics to show the relationships among the sciences. Wherever possible, examples should be framed in the context of the learners' own experiences to enable them to make the connections between scientific knowledge and the society around them, the technology that societies have developed, and the nature of science itself.

COURSE OVERVIEW

The Science 10 course emphasizes four of the key concepts of science: *change, energy, matter* and systems. The concepts of *diversity* and *equilibrium* are included as well but receive less emphasis. These themes provide a means of showing the connections among the scientific disciplines, and provide a framework for teachers to show students how individual sections of the course relate to the big ideas of science.

In addition to developing a solid understanding of the fundamental science concepts and principles, Science 10 has the goal of educating students about the nature of science and technology, and the interaction between science and technology. Students must be aware of the tremendous impact of science and associated technology on society, but at the same time they must be aware of the roles and limitations of the sciences and technology in problem solving in a societal context.

The major concepts allow connections to be drawn among the four units of the course.

Science 10 consists of four units of study:

Unit 1: Energy from the Sun
Unit 2: Energy and Matter in Living Systems
Unit 3: Energy and Matter in Chemical Change
Unit 4: Change and Energy.

Unit 1 focuses on the role of radiant energy from the Sun in sustaining life and driving weather *systems* on Earth. In Unit 2, the processes by which *energy* and *matter* are exchanged between living *systems* and their environment are studied, and change is illustrated by the growth of living organisms. Unit 3 investigates the *changes* in *energy* and *matter* that occur during chemical reactions. Unit 4 examines different forms of *energy* and the principles that govern *energy* transformations.

UNIT 1
ENERGY FROM THE SUN

OVERVIEW

Science Themes: *Energy, Matter* and *Systems*

In Unit 1, students investigate how radiant *energy* from the Sun sustains life and drives weather *systems* on Earth. The properties of water are studied and compared with the properties of other forms of *matter*. Students investigate the role of water in moderating the *changes* in the Sun's *energy* as it moves through the biosphere.

This unit builds on Science 8, Unit 5: Growing Plants; and Science 9, Unit 3: Heat Energy: Transfer and Conservation, and provides students with a foundation for the study of *ecosystems* and alternative *energy* sources in the 20- and 30-level science courses.

The three **major concepts** developed in this unit are:

- *energy* from the Sun sustains life on Earth
- the properties of water, relative to other forms of *matter*, profoundly influence the nature of life on Earth
- *energy* from the Sun determines climate and drives weather *systems*.

In this unit, *students will develop* an ability to use the skills and **thinking processes** associated with the practice of science, emphasizing:

- collecting and recording
- organizing and communicating
- analyzing data from investigations of the Sun's *energy* and the properties of water.

The **STS connections** in this unit illustrate:

- the functioning of products or processes based on scientific principles
- the use of technology to solve practical problems
- the limitations of scientific knowledge and technology.

ATTITUDES

Students will be encouraged to:

- develop a questioning attitude concerning natural phenomena
- appreciate the importance of solar *energy* in sustaining life and driving weather *systems* on Earth
- appreciate the importance of water in determining the nature of life on Earth
- recognize that scientific knowledge of meteorological phenomena is cumulative and subject to *change*
- recognize the limits of current scientific theories in predicting natural phenomena, such as weather.

MAJOR CONCEPT	KNOWLEDGE
	Students should be able to demonstrate an understanding that:
1. *Energy* from the Sun sustains life on Earth.	• energy from the Sun sustains life on Earth, by extending from Science 8, Unit 5, the life processes of plants, and by: • defining photosynthesis as the process by which green plants (consumers) put together carbon dioxide and water to store energy and form carbohydrates and oxygen • defining aerobic respiration as the process by which organisms (producers) release energy by reacting on carbohydrates and oxygen to form carbon dioxide and water • describing how photosynthesis and aerobic respiration are the reverse of each other • indicating that all life on Earth exists in the biosphere, a relatively thin spherical shell having an approximate thickness of 15 kilometres • indicating that the biosphere exists within the three major spherical layers of Earth—the atmosphere, the hydrosphere and the lithosphere • explaining how energy flow through the biosphere is facilitated by different types of organisms; i.e., producers, consumers and decomposers • defining open, closed and isolated systems; i.e., – open system: exchanges both energy and matter with its surroundings – closed system: exchanges energy but not matter with its surroundings – isolated system: does not exchange matter or energy with its surroundings.

SKILLS	STS CONNECTIONS
Students should be able to demonstrate the skills and thinking processes associated with the practice of science, by:	*Students should be able to demonstrate the interrelationships among science, technology and society, by:*

• performing an experiment to demonstrate the role of light energy in the production of carbohydrates and oxygen by green plants
• identifying the manipulated, responding and controlled variables (variables held constant) in an experimental investigation of photosynthesis
• distinguishing between a controlled variable and a control experiment (an experiment carried out under the same conditions as another experiment except for one factor)
• designing a closed system to illustrate the dynamic balance between photosynthesis and respiration
• tracing the flow of energy through the biosphere, interrelating autotrophic and heterotrophic matter needs by comparing representative producers and consumers.
	• understanding that energy from the Sun sustains life in the biosphere through the processes of photosynthesis and respiration, within the context of:
	  • tracing the energy contained in a typical student lunch to its source in the Sun, using the laws of thermodynamics
	  OR
	  • describing the ability and responsibility of society, through science and technology, to protect the environment and use natural resources judiciously to ensure quality of life for future generations; e.g., global deforestation
	  OR
	  • investigating the ways in which technology advances science; e.g., attempts to establish artificial ecosystems in a large closed system, such as Biosphere II
	  OR
	  • any other relevant context.

MAJOR CONCEPT	KNOWLEDGE
	Students should be able to demonstrate an understanding that:
2. The properties of water, relative to other forms of *matter*, profoundly influence the nature of life on Earth.	• the properties of water, including surface tension, melting point, boiling point, specific heat capacity, heat of fusion, heat of vaporization, expansion on freezing, and maximum density at 4°C, profoundly influence the nature of life on Earth, by: • extending from Science 9, Unit 3, that heat is a form of energy and may be quantified using $Q = mc\Delta T$ • calculating the thermal energy involved when a measured mass of water undergoes a measured temperature change • calculating the thermal energy involved when a measured mass of water undergoes a phase change • relating the hydrologic cycle to solar energy • relating the properties of water to the maintenance of constant body temperature • indicating why ice forms on the surface of water, and relating this to the winter survival of aquatic organisms • describing how the properties of water are due to the polar nature of the water molecule • explaining the effect of thermal energy on matter, using the kinetic molecular theory as a simple mechanical model • describing temperature changes in terms of changes in the kinetic energy of the molecules of a substance • describing phase changes in terms of the kinetic molecular theory.

SKILLS	STS CONNECTIONS
Students should be able to demonstrate the skills and thinking processes associated with the practice of science, by:	*Students should be able to demonstrate the interrelationships among science, technology and society, by:*
	• understanding that the properties of water, including surface tension, melting point, boiling point, specific heat capacity, heat of fusion, heat of vaporization, expansion on freezing, and maximum density at 4°C, profoundly influence the nature of life on Earth, including the maintenance of constant body temperature, the winter survival of aquatic organisms; and the operation of the hydrologic cycle, within the context of:
• observing and recording some of the physical properties of water • collecting and graphing data showing the effect of heat on the temperature of water • performing an experiment to determine the heat of fusion of ice • calculating any variable in the equation, $Q = mc\Delta T$, given the other three variables • graphing and analyzing data showing how the density of water varies with temperature • designing an experiment to investigate the change in volume of water upon freezing.	• explaining the scientific principles involved in the technologies that use water to maintain a uniform temperature in buildings OR • describing the use of technology to solve practical problems; e.g., construction methods that account for the expansion of water upon freezing; and technologies that use solar energy to desalinate water OR • any other relevant context.

MAJOR CONCEPT	KNOWLEDGE
	Students should be able to demonstrate an understanding that:
3. *Energy* from the Sun determines climate and drives weather *systems.*	• energy from the Sun determines climate and drives weather systems, by:
	• explaining the principal factors that determine climate; i.e., large bodies of water, ocean currents, latitude, surface characteristics
	• explaining the significance of the differential solar heating of equatorial and polar regions in the transfer of thermal energy
	• explaining weather changes in terms of pressure systems, cold and warm fronts, and the Coriolis effect
	• explaining a local weather phenomenon; e.g., chinooks, thunderstorms, hailstorms or tornadoes.

SKILLS	STS CONNECTIONS
Students should be able to demonstrate the skills and thinking processes associated with the practice of science, by:	*Students should be able to demonstrate the interrelationships among science, technology and society, by:*
	• understanding that weather systems, such as chinooks, thunderstorms, hailstorms and tornadoes, are driven by energy from the Sun through the mechanisms of vertical air currents, pressure systems, cold and warm fronts and the Coriolis effect, and that climate is strongly effected by large bodies of water, ocean currents and latitude, within the context of:
• comparing mean monthly temperature data for cities of similar latitude and accounting for any differences	• describing the use of technology to solve practical problems; e.g., the operation of weather satellites in monitoring weather systems
• constructing and interpreting climate graphs	OR
• designing an experiment to investigate the heating effect of solar energy	• describing the limitations of scientific knowledge and technology; e.g., how more accurate weather predictions could benefit millions of people globally
• performing an experiment to investigate the heat changes involved in the compression and expansion of air	OR
• communicating meteorological data in SI units; e.g., temperature, wind velocity, atmospheric pressure, precipitation	• describing the technology used to monitor levels of atmospheric gases
• interpreting weather maps of local weather	OR
• comparing weather forecasts to observed weather.	• describing the central role of experimental evidence in the accumulation of knowledge, and the way in which proposed theories may be supported, modified or refuted; e.g., using a greenhouse as a model of Earth's atmosphere
	OR
	• any other relevant context.

UNIT 2
ENERGY AND MATTER IN LIVING SYSTEMS

OVERVIEW

Science Themes: *Energy, Matter* and *Systems*

In Unit 2, students investigate how *energy* and *matter* are exchanged between living *systems* and their environment, and examine the *changes* involved in the growth of living organisms. The energetics of diffusion, osmosis and active transport are analyzed. The limitations that diffusion places on growth, and the significance of transport in multicellular organisms are examined.

This unit builds upon Science 8, Unit 5: Growing Plants, and Unit 6: Interactions and Environments, and continues from Science 10, Unit 1: Energy from the Sun, the study of photosynthesis and respiration. The knowledge, skills and attitudes developed in this unit provide students with a sound background for the further study of living *systems* in Biology 20 and Science 20.

The four **major concepts** developed in this unit are:

- the cell is the basic unit of living *systems*
- growth is a major feature of living *systems*, and a major limitation to growth is the surface area to volume ratio of the cell
- the cell is an open *system* exchanging *energy* and *matter* with the environment
- organisms provide for *energy* and *matter* needs at a distance from the organism's interface with the environment.

In this unit, *students will develop* an ability to use the **skills and thinking processes** associated with the practice of science, emphasizing:

- collecting and recording
- organizing and communicating
- analyzing data from investigations of living *systems*.

The **STS connections** in this unit illustrate:

- the functioning of products or processes based on scientific principles
- the ways in which science advances technology and technology advances science
- the use of technology to solve practical problems.

ATTITUDES

Students will be encouraged to:

- appreciate the unity of science through the application of physical and chemical principles to biological *systems*
- appreciate that biological principles emerge from the investigation of the structure and function of living *systems*
- appreciate that many fundamental biological processes operate at both the cellular and higher levels of organization
- appreciate that the maintenance of homeostasis relies on *equilibria* within the organism and between the organism and its environment
- develop a curiosity to obtain a deeper understanding of biological *systems*
- appreciate that our knowledge of biology has been enhanced by the application of technology
- appreciate that the application of technology can have beneficial and harmful effects on biological *systems*.

MAJOR CONCEPT	KNOWLEDGE
	Students should be able to demonstrate an understanding that:
1. The cell is the basic unit of living *systems.*	• the cell is the basic unit of living systems, by:
	• identifying and briefly describing the structure and function of the nucleus, nucleoid, endoplasmic reticulum, Golgi apparatus, lysosome, vacuole, mitochondrion, chloroplast, ribosome, cytoskeleton and cell wall, where present, in bacteria, plant and animal cells
	• identifying, and briefly describing, the structure and function of the cell membrane in relation to cell equilibrium, and active and passive transport
	• describing the similarities and differences in the structure and function of prokaryotic and eukaryotic cells
	• describing the structure and use of a compound microscope.

SKILLS	STS CONNECTIONS
Students should be able to demonstrate the skills and thinking processes associated with the practice of science, by:	*Students should be able to demonstrate the interrelationships among science, technology and society, by:*
	• understanding that the cell is the basic unit of life; and describing the structure and function of the cell membrane and selected organelles in both prokaryotic and eukaryotic cells, and by preparing tissue for observation, observing and identifying cellular structures, and estimating size and magnification, within the context of:
• drawing analogies between the evidence for division of labour within cells to services in communities	• describing how advancements in knowledge of cell structure increased as a direct result of developments in microscope technology, including electron microscopes
• identifying cellular structures in living and prepared materials by using dissecting and compound microscopes and by examining electron micrographs	OR
• preparing plant and animal material for microscopic examination, using stains and observing the materials	• assessing the needs, interests and financial support of society on the development of the electron microscope, a Canadian invention
• calculating magnification, field of view and scale	OR
• calculating the size of a cell from a knowledge of microscope magnification power and field of view.	• any other relevant context.

MAJOR CONCEPT	KNOWLEDGE
	Students should be able to demonstrate an understanding that:
2. Growth is a major feature of living *systems*, and a major limitation to growth is the surface area to volume ratio of the cell.	• growth is a major feature of living systems, and a major limitation to growth is the surface area to volume ratio of the cell, by: • describing what is meant by growth in terms of both an increase in the number of cells by fission or mitosis, and the increase in volume or mass of a cell or organism • describing how the surface area to volume ratio of a cell might limit its growth, and inferring the value of multicellularity in enhancing the ability to use nutrients • explaining how division of labour occurs within a single cell and, after the process of differentiation, in a multicellular organism.

SKILLS	STS CONNECTIONS
Students should be able to demonstrate the skills and thinking processes associated with the practice of science, by:	*Students should be able to demonstrate the interrelationships among science, technology and society, by:*
	• understanding that growth is a major feature of living systems; and explaining how surface area to volume ratio is the major limitation to growth, describing cell division, multicellularity and division of labour; and by observing growing plant cells and calculating and comparing surface area to volume ratios in various organisms, within the context of:
• observing and recording macroscopic and microscopic changes in a growing plant for evidence of differentiation	• describing the use of technology to solve practical problems; e.g., bacterial products or processes used in research and industry
	OR
• calculating and graphing the surface area to volume ratios of a variety of model cell sizes and shapes, when one variable is changed at a time	• identifying and explaining examples of surface area maximization in technological and natural systems that facilitate transfer of thermal energy, gases, nutrients or wastes
	OR
• comparing the surface area to volume ratio of various organisms and relating the findings to the organisms' metabolic rates; e.g., hummingbird or shrew compared with elephant or whale.	• any other relevant context.

MAJOR CONCEPT	KNOWLEDGE
	Students should be able to demonstrate an understanding that:
3. The cell is an open *system* exchanging *energy* and *matter* with the environment.	• the cell is an open system exchanging energy and matter with the environment, by extending from Science 8, Unit 5, the life processes of plants, and by:
	• describing how materials diffuse across a cell membrane in terms of concentration gradients
	• describing how the semipermeable nature of the cell membrane allows the process of osmosis
	• describing, in general terms, how the energy in light is converted to chemical energy
	• describing, in general terms, how carbon dioxide molecules in solution, or in the air, are fixed as carbohydrates in the plant chloroplasts, using the stored light energy
	• describing how adenosinetriphosphate (ATP) is used to do the work of transporting substances across membranes against their concentration gradients; i.e., active transport, endocytosis and exocytosis
	• describing, in general terms, how the energy for active transport is derived from photosynthesis and respiration in the form of ATP.

SKILLS	STS CONNECTIONS
Students should be able to demonstrate the skills and thinking processes associated with the practice of science, by:	*Students should be able to demonstrate the interrelationships among science, technology and society, by:*
	• understanding that the cell is an open system, using both active and passive processes to exchange energy and matter with the environment, and that the energy for active transport is derived from photosynthesis and respiration in the form of ATP; and by performing experiments demonstrating matter exchange processes in plants and dialysis tubing, and researching types of nutrient acquisition in selected plants and animals, within the context of:
• investigating the different action of a sucrose solution and a starch solution when placed in separate dialysis bags and immersed in water, and inferring why the solutions behave differently • performing an experiment to demonstrate the phenomena of plasmolysis and deplasmolysis in plant cells; e.g., staminal hairs or aquatic leaf cells, and describing the observed events in terms of the tonicity of the cells and solutions • inferring how biochemical interconversion of starch and glucose might regulate the turgor pressure of cells • observing and/or researching nutrient acquisition at the cellular level.	• explaining the scientific principles behind eating solid food and organism nutrition OR • explaining how a knowledge of diffusion and osmosis can be used in technological applications; e.g., desalination of sea water, peritoneal or mechanical dialysis OR • describing how gas compression technology has been used to solve the practical problems encountered by humans working in high altitudes or deep oceans, and explaining what happens in altitude sickness and caisson disease OR • summarizing articles, based on the scientific principles of energy and matter exchange, the latest scientific and/or technological developments; e.g., kidney research OR • explaining the scientific principles and processes involved in oral rehydration therapy used to treat cholera OR • any other relevant context.

MAJOR CONCEPT	KNOWLEDGE
	Students should be able to demonstrate an understanding that:
4. Organisms provide for *energy* and *matter* needs at a distance from the organism's interface with the environment.	• organisms provide for energy and matter needs at a distance from the organism's interface with the environment, by extending from Science 9, Unit 1, that living things show a diversity of structural adaptation, and by:
	• comparing how selected organisms transport nutrients and wastes over short and long distances, and discussing the differences in terms of the structure and function of the organisms; e.g., unicellular and multicellular
	• comparing how selected organisms acquire nutrients and remove wastes, and discussing the differences in terms of the structure and function of the organisms; e.g., unicellular and multicellular
	• comparing how selected organisms exchange gases, and discussing the differences in terms of the structure and function of the organisms; e.g., unicellular and multicellular
	• explaining the movement of water in plants in terms of the polar nature of water.

SKILLS

Students should be able to demonstrate the skills and thinking processes associated with the practice of science, by:

- observing and describing the appearance of cytoplasmic streaming in *Amoeba* or a plant cell, and inferring similar movement in most cells of a multicellular organism
- identifying diverse pairs or organisms and comparing them with respect to transport systems; e.g., *Amoeba* and giraffe, a single-celled alga and a redwood tree
- observing, recording and explaining the movement of water in plants.

STS CONNECTIONS

Students should be able to demonstrate the interrelationships among science, technology and society, by:

- understanding how multicellular organisms exchange energy and matter between their cells and the environment, describing multicellular transport mechanisms, comparing nutrient acquisition, waste excretion, and gas exchange; and by observing cytoplasmic streaming in the *Amoeba*, water movement in plants, and observing and comparing transport systems in diverse pairs of organisms, within the context of:
  - explaining biological processes in terms of the scientific principles involved; e.g., nutrient distribution in multicellular organisms

    OR
  - describing the use of technology to solve practical problems; e.g., the use of vacuum-tapping system technology of sap recovery while taking advantage of the natural transport system of maple trees

    OR
  - describing the processes involved in the uptake and distribution of systemic pesticides in the treatment of plant diseases; e.g., the fungicide used to treat Dutch elm disease

    OR
  - any other relevant context.

UNIT 3
ENERGY AND MATTER IN CHEMICAL CHANGE

OVERVIEW

Science Themes: *Change, Energy* and *Matter*

In Unit 3, students investigate how *energy* and *matter* are involved in chemical *change*. Students study the patterns among the properties of the elements that form the basis of the periodic table. A simple model of the atom is presented to explain the chemical properties of *matter* and the *energy* effects of chemical *change*. To deal with the vast array of compounds created by combining elements, the International Union of Pure and Applied Chemistry (IUPAC) system of chemical nomenclature is introduced.

This unit builds on Science 8, Unit 1: Solutions and Substances; and Science 9, Unit 5: Chemical Properties and Changes, and provides students with a foundation for the further study of chemical *change* in Science 20 and Chemistry 20.

The five **major concepts** developed in this unit are:

- *matter* is classified on the basis of its properties
- *matter* has a well-defined underlying structure
- elements combine to form a vast array of compounds
- *energy* is involved in each *change* that *matter* undergoes
- *matter* is conserved in chemical *changes*.

In this unit, *students will develop* an ability to use the **skills** and **thinking processes** associated with the practice of science, emphasizing:

- collecting and recording
- organizing and communicating
- analyzing data from investigations of chemical *change*.

The **STS connections** in this unit illustrate:

- the ways in which science advances technology and technology advances science
- the influence of the needs, interests and financial support of society on scientific and technological research
- the ability and responsibility of society, through science and technology, to protect the environment and use natural resources judiciously to ensure quality of life for future generations.

ATTITUDES

Students will be encouraged to:

- appreciate the orderliness of nature and the characteristic pattern in the properties of *matter*
- appreciate that careful and precise observations form the basis for generalizations about the nature of *matter*
- tolerate the uncertainty in our explanations of the nature of *matter*
- value the contribution of science and technology to our understanding of the nature of *matter*
- value the need for safe handling and disposal of chemicals
- demonstrate an awareness of the impact that humankind has had on the environment through the manipulation of *matter* for personal and industrial use
- appreciate the benefits that have resulted from applications based on chemical principles.

MAJOR CONCEPT	KNOWLEDGE
	Students should be able to demonstrate an understanding that:
1. *Matter* is classified on the basis of its properties.	• matter is classified on the basis of its properties, by extending from Science 8, Unit 1, and Science 9, Unit 5, the major categories of matter (e.g., pure substance, mixture, element, compound, solution) and the differences between physical and chemical properties, and by: • explaining that matter is everything that has mass and occupies space • explaining the classification of the first 20 elements in the periodic table in terms of chemical properties • predicting the properties of elements from their position on the periodic table, and the placement of elements on the periodic table from their properties • identifying the elements that are most prevalent in living systems.

SKILLS	STS CONNECTIONS
Students should be able to demonstrate the skills and thinking processes associated with the practice of science, by:	*Students should be able to demonstrate the interrelationships among science, technology and society, by:*
• handling reactive materials safely • using observation and experimentation to study the properties of matter, and to classify various examples of matter • observing physical and chemical properties of representative elements, noting the patterns.	• understanding the classification of matter based on physical and chemical properties, the placement of elements on the periodic table, identifying elements prevalent in living systems; and by handling reactive materials safely, using separation techniques, and investigating and classifying matter, using laboratory tests, within the context of: • describing how WHMIS symbols are used to classify potentially hazardous materials; and explaining the need for such systems to protect ourselves and the environment from harm OR • describing some of the physiological effects of heavy metals, such as lead or mercury, and the possible sources of contamination in everyday life; and explain the limitations of scientific knowledge and technology in providing complete answers to all questions OR • explaining why most metals must be separated from their ores and protected from corrosion, an example of the functioning of products or processes based on scientific principles OR • any other relevant context.

MAJOR CONCEPT	KNOWLEDGE
	Students should be able to demonstrate an understanding that:

2. *Matter* has a well-defined underlying structure.	• matter consists of atoms, ions and molecules, by:
	  • providing definitions for the following chemical species: atoms (isotope), ions, molecules
	  • indicating relative size, charge and mass of electrons, protons and neutrons
	  • indicating the relative sizes of atoms, ions and molecules
	  • describing the extent to which we are able to "observe" chemical species with modern technology.

SKILLS	STS CONNECTIONS
Students should be able to demonstrate the skills and thinking processes associated with the practice of science, by:	*Students should be able to demonstrate the interrelationships among science, technology and society, by:*
• describe in words, diagrams and/or models, the structure of the atoms of the first 20 elements, including protons, neutrons and electrons.	• understanding what is meant by the following chemical species: atoms (isotopes), ions and molecules, their relative size and the extent to which modern technology allows us to "observe" them; and by building models of atomic structure, within the context of: • illustrating, with examples, how isotopes are used in medical research and treatment as evidence of the functioning of products and processes based on scientific principles OR • outlining the merits of spending public money on investigating atomic structure, and the influence of the needs, interests and financial support of society on scientific and technological research OR • any other relevant context.

MAJOR CONCEPT	KNOWLEDGE
	Students should be able to demonstrate an understanding that:
3. Elements combine to form a vast array of compounds.	• elements combine to form compounds that have characteristic properties and are assigned individual names, by: • differentiating, on the basis of properties (conductivity, pH) and formulas, between ionic and molecular compounds, including acids and bases • identifying the role of several compounds in living systems; i.e., water, hydrochloric acid, glucose, ATP, fats • naming and writing formulas for common ionic and molecular compounds and acids, using a periodic table and a list of polyatomic ions • using a solubility chart to determine if an ionic compound will dissolve in water.

SKILLS	STS CONNECTIONS
Students should be able to demonstrate the skills and thinking processes associated with the practice of science, by:	*Students should be able to demonstrate the interrelationships among science, technology and society, by:*
• investigating the properties of representative ionic and molecular compounds, including acids and bases, in laboratory experiments, and in resources, such as a chemistry handbook • using equipment, such as Bunsen burners and laboratory glassware, correctly and safely • handling and disposing of chemicals in a safe, responsible manner.	• understanding that elements combine to form compounds; identifying compounds important to living systems; providing names and formulas for compounds; and by investigating and classifying compounds, using laboratory tests, within the context of: • describing several compounds that are essential to human health and several that are hazardous to human health or the environment; and explaining the need for such knowledge to protect ourselves and the environment from harm OR • explaining the importance of the International Union of Pure and Applied Chemistry (IUPAC) system of naming compounds in terms of the work that scientists do and the need to communicate clearly OR • describing the disposal problem related to used materials in terms of the ability and responsibility of society to protect the environment and use natural resources judiciously to ensure quality of life for future generations OR • outlining safe methods for handling potentially hazardous substances in the home and laboratory; and explaining the need for such knowledge to protect ourselves and the environment from harm OR • any other relevant context.

MAJOR CONCEPT	KNOWLEDGE
	Students should be able to demonstrate an understanding that:

4. *Energy* is involved in each *change* that *matter* undergoes.	• energy is involved in each change that matter undergoes, by:
	• comparing and contrasting physical and chemical changes
	• describing evidence of chemical reactions; i.e., energy change, formation of a gas, formation of a precipitate, colour change, odour change
	• differentiating between endothermic and exothermic changes
	• identifying types of chemical reactions; i.e., formation, decomposition, combustion, single replacement and double replacement
	• writing word equations for chemical reactions that occur in living and nonliving systems; e.g.,
	  • carbon dioxide + water + energy → glucose + oxygen
	  • glucose + oxygen → carbon dioxide + water + energy
	  • zinc + sulfur → zinc sulfide + energy
	  • water + energy → hydrogen + oxygen
	  • methane + oxygen → carbon dioxide + water + energy
	  • copper + silver nitrate → silver + copper(II) nitrate + energy
	  • lead(II) nitrate + potassium iodide → potassium nitrate + lead(II) iodide + energy
	• translating word equations into chemical equations and translating chemical equations into word equations.

SKILLS	STS CONNECTIONS
Students should be able to demonstrate the skills and thinking processes associated with the practice of science, by:	*Students should be able to demonstrate the interrelationships among science, technology and society, by:*
• performing experiments that illustrate chemical changes, including endothermic and exothermic examples.	• understanding that energy is involved in all physical and chemical transformations of matter; and identifying and writing word/chemical equations for chemical reactions; and by performing experiments that illustrate chemical changes, within the context of: • providing examples of household, commercial and industrial processes that use physical and/or chemical changes to produce useful substances and energy OR • identifying chemical reactions that are harmful to the environment; e.g., destruction of the ozone layer by chlorofluorocarbons, formation of acid rain and greenhouse gases; and explaining the ability and responsibility of society, through science and technology, to protect the environment and use natural resources judiciously to ensure quality of life for future generations OR • any other relevant context.

MAJOR CONCEPT	KNOWLEDGE
	Students should be able to demonstrate an understanding that:
5. *Matter* is conserved in chemical *changes.*	• the conservation of mass in chemical changes can be illustrated and quantified, by: • outlining experiments, such as van Helmont's and Lavoisier's, that establish the law of conservation of mass • writing chemical equations that include the state of matter for each substance, and balancing the equations in terms of chemical species and moles; predicting the products of reactions is not required.

SKILLS	STS CONNECTIONS
Students should be able to demonstrate the skills and thinking processes associated with the practice of science, by:	*Students should be able to demonstrate the interrelationships among science, technology and society, by:*
	• understanding that mass is conserved in chemical changes by writing balanced chemical equations; and by performing experiments, doing measurements and calculations to illustrate the conservation of matter in chemical change, within the context of:
• performing an experiment that demonstrates the principles behind Lavoisier's experiments on combustion, which led to the conclusion that burning substances gain mass by combining with oxygen from the air	• explaining the significance of using technologies in analytical chemistry, such as balances, calculators and computers as examples of how science advances technology and technology advances science
• illustrating that mass is conserved during a chemical reaction in a closed system	OR
• predicting relative solubility of selected ionic compounds using a solubility chart and/or experimentation.	• any other relevant context.

UNIT 4
CHANGE AND ENERGY

OVERVIEW

Science Themes: *Change* and *Energy*

In Unit 4, students quantitatively investigate *energy changes* and develop their understanding of *energy* transformation and conservation. The unit concludes with a project in which students design and build a simple *energy* conversion device and evaluate its efficiency.

This unit builds on Science 7, Unit 3: Force and Motion, and Unit 4: Temperature and Heat Measurement; Science 9, Unit 3: Heat Energy: Transfer and Conservation, and extends the concepts of *energy* transformation introduced in Unit 1, and treated in their biological and chemical contexts in Unit 2 and Unit 3. The knowledge, skills and attitudes developed in this unit provide students with a foundation for the study of energy and conservation topics in Science 20 and Physics 20.

The four **major concepts** developed in this unit are:

- *energy* is always associated with *change*
- *energy* can be transformed from one form to another
- *energy* cannot be created or destroyed, only converted from one form into another
- useful *energy* diminishes during any *energy* transformation.

In this unit, *students will develop* an ability to use the **skills** and **thinking processes** associated with the practice of science, emphasizing:

- collecting and recording
- organizing and communicating
- analyzing data from investigations of *energy* change.

The **STS connections** in this unit illustrate:

- the functioning of products or processes based on scientific principles
- the use of technology to solve practical problems
- the ability and the responsibility of society, through science and technology, to protect the environment and use natural resources judiciously to ensure quality of life for future generations.

ATTITUDES

Students will be encouraged to:

- develop a positive attitude toward mathematical, communication and scientific processes and skills in the study of *energy*
- appreciate the need for computational competence in quantifying *energy* and *energy* transfers
- respect evidence when interpreting observed phenomena related to *energy*
- appreciate that science is a disciplined way to develop explanations and descriptions about *energy* in the natural and technological world
- accept uncertainty in our descriptions and explanations of observations related to *energy* in the physical world.

MAJOR CONCEPT	KNOWLEDGE
	Students should be able to demonstrate an understanding that:
1. *Energy* is always associated with *change*.	• energy is always associated with change, by extending from Science 8, Unit 2, the definition of mechanical work, and quantifying the work done on/by an object, using $W=Fd$; by extending from Science 7, Unit 3, the notions of force, mass and weight; and by:
	• defining kinetic energy as energy due to motion, and potential energy as energy due to position or condition
	• illustrating, by use of examples, that energy exists in a variety of forms; e.g., mechanical, chemical, electrical, thermal, nuclear, solar
	• illustrating, by use of examples, that the Sun is the source of most energy forms on Earth
	• describing one-dimensional uniform motion, using words, graphs and formulas; e.g., $v=\frac{\Delta d}{\Delta t}$
	• defining energy as the property of a system that is a measure of its capacity for doing work, and work is the transfer of energy
	• deriving the SI unit of energy and work, the joule, from fundamental units.

SKILLS	STS CONNECTIONS
Students should be able to demonstrate the skills and thinking processes associated with the practice of science, by:	*Students should be able to demonstrate the interrelationships among science, technology and society, by:*
	• understanding that energy, existing in a variety of forms, is always associated with change, and that the Sun is the source of most energy forms on Earth; and describing the relationship between energy and work, and one-dimensional motion, using graphical and mathematical techniques; and by tracing the flow of energy from the Sun; and by gathering, numerically analyzing and graphing data relevant to the relationships among distance, speed, time and force, distance and work, within the context of:
• making a synopsis of energy as it has been discussed in earlier units • tracing the flow of energy from the Sun to the lighting system in the school, identifying what changes are taking place at each stage of the process • performing an experiment to determine the relationships among distance, speed and time for uniform motion • calculating the slope of the line in a distance–time graph to determine speed • calculating the area under the line in a speed–time graph to determine the distance travelled • calculating the area under the line in a force–distance graph to determine work done.	• discussing, qualitatively, the importance of the Sun as an energy source for life on Earth in terms of the energy conversion processes involved OR • describing the functioning technologies that address the problem of providing current energy sources OR • any other relevant context.

MAJOR CONCEPT	KNOWLEDGE
	Students should be able to demonstrate an understanding that:
2. *Energy* can be transformed from one form to another.	• energy can be transformed from one form to another, by extending from Science 7, Unit 4, that thermal energy can be derived from a variety of sources; and by: • recognizing that potential energy is only useful when it is transformed to some form of kinetic energy • illustrating, by use of examples, that energy transfers produce measurable changes in motion, shape or temperature of matter • defining gravitational potential energy as the work done on a mass against gravity, and quantifying gravitational potential energy, using $E_p = mgh$ • quantifying kinetic energy, using $E_k = 1/2mv^2$ • recognizing chemical energy as a form of potential energy; e.g., glucose, ATP, gasoline, lead–acid battery • quantifying electrical energy, using $E_e = Pt$ • analyzing units to describe the kilowatt hour as a unit of energy, and the watt as a unit of rate of energy transfer or a unit of rate of doing work.

SKILLS	STS CONNECTIONS
Students should be able to demonstrate the skills and thinking processes associated with the practice of science, by:	*Students should be able to demonstrate the interrelationships among science, technology and society, by:*
	• understanding that energy can be transformed from one form to another, and quantifying these transformations; and explaining that energy transfers produce measurable changes in motion, shape or temperature of matter; and by empirically investigating energy conversions; and by calculating the energy consumption of selected technologies given relevant data, within the context of:
• calculating the energy consumption of selected household technologies; e.g., toaster, microwave oven, refrigerator	• describing, qualitatively, current technologies used to convert energy from one form to another; e.g., hydroelectric and coal-burning power stations, solar cells
	OR
• discussing an experiment to demonstrate the conversion of chemical potential energy to thermal energy, involving a combustion reaction	• describing, qualitatively, technological devices that use chemical potential energy as an energy source in terms of their function and the practical problems addressed
	OR
• performing an experiment to demonstrate the conversion of energy from a potential form to a kinetic form, using a pendulum	• analyzing, in terms of scientific principles, the energy transfers occurring as an automobile or a bicycle comes to a stop
	OR
• performing an experiment to demonstrate the equivalency of work done on an object, and the resulting kinetic energy.	• any other relevant context.

MAJOR CONCEPT	KNOWLEDGE
	Students should be able to demonstrate an understanding that:
3. *Energy* cannot be created or destroyed, only converted from one form into another.	• conservation of energy is a fundamental law of nature, by: • stating the law of conservation of energy as "the sum of initial energies is equal to the sum of final energies" • recognizing the first law of thermodynamics as a statement of the law of conservation of energy • describing, by use of examples, that thermal energy will, of its own accord, flow from a hotter body to a cooler body, and recognizing this as a formal statement of the second law of thermodynamics • comparing the mechanism of diffusion to thermal energy transfer according to the second law of thermodynamics.

SKILLS	STS CONNECTIONS
Students should be able to demonstrate the skills and thinking processes associated with the practice of science, by:	*Students should be able to demonstrate the interrelationships among science, technology and society, by:*
	• understanding that energy cannot be created or destroyed, and that thermal energy flows, of its own accord, from a hotter body to a cooler one; and by tracing energy conversions in selected systems; and by experimentally investigating conservation of energy in a closed system, and the similarities between diffusion and thermal energy transfer, within the context of:
• tracing the stages of energy conversion in a system; e.g., a power plant or food chain, and identifying the sources of energy loss	• describing, qualitatively, the energy transfer processes in terms of scientific principles in various conversion systems; e.g., refrigerator, heat pump, thermal power plant, food chain OR
• performing an experiment to demonstrate the similarities between diffusion and thermal energy transfer.	• commenting on the feasibility of perpetual motion machines in terms of the laws of thermodynamics OR
	• comparing and contrasting the energy transfers and technologies in a hydroelectric plant and a thermal power plant in terms of the laws of thermodynamics OR
	• discussing the role of alternative energy sources to generate energy in Alberta considering society's responsibility to protect the environment and use natural resources judiciously OR
	• any other relevant context.

MAJOR CONCEPT	KNOWLEDGE
	Students should be able to demonstrate an understanding that:
4. Useful *energy* diminishes during any *energy* transformation.	• the amount of useful energy diminishes during any energy transformation, by:
	• interpreting empirical data from a study of energy conversions
	• explaining that energy conversion processes have different efficiencies, based on total energy input compared to the net useful energy output
	• defining inefficiency as the fraction of energy lost as wasted heat in the conversion process
	• describing techniques for reducing waste of energy, in a common household device.

SKILLS	STS CONNECTIONS
Students should be able to demonstrate the skills and thinking processes associated with the practice of science, by:	*Students should be able to demonstrate the interrelationships among science, technology and society, by:*
	• understanding that during any energy transformation the useful energy diminishes, and describing thermal energy waste reduction techniques; and by quantifying the efficiency of common heating devices; and performing experiments demonstrating the conversion of mechanical and electrical energy into thermal energy, within the context of:
• conducting an investigation in which the efficiency of common technological devices used to heat a specific amount of water is quantified and evaluated	• comparing and contrasting the energy content of fuels used in thermal power plants in Alberta on the basis of scientific principles and the need to protect the environment and use our natural resources judiciously
	OR
• performing an experiment in which mechanical energy is converted into heat energy	• discussing the role of efficiency of energy conversions to encourage responsible energy use in order to protect our environment and use our natural resources judiciously
	OR
• designing and building an energy conversion device and calculating its efficiency.	• discussing the impact of displaying energy consumption labels on household appliances in terms of the needs and interests of society
	OR
	• any other relevant context.

D. BASIC LEARNING RESOURCES

Braaten, Audrey et al. *Visions 1.* Toronto, ON: Gage Educational Publishing Company, 1992. [student textbook]

ISBN 0771530080

Blades, David W. *Visions 1 Teacher's Guide.* Toronto, ON: Gage Educational Publishing Company, 1992.

ISBN 0771530099

DATE DUE SLIP

F255

University of Alberta Library
0 1620 0134 3597